Smith Creek
Water Quality Monitoring Group

VOLUNTEER WATER QUALITY MONITORING OVERVIEW

Wake Forest residents have been developing a keen interest in the water quality of their local neighborhood stream. Many things can have an impact on water quality, affecting a stream's health. High levels of bacteria could indicate sanitary sewer leaks of sewage into streams. High levels of nutrients, such as nitrogen and phosphorus, can cause algae growth in Wake Forest and downstream in the Neuse River, which can cause fish kills by depleting dissolved oxygen from the water. Sediment is North Carolina's largest pollutant of waterways. Sediment is often seen as the reddish orange clouds within the water immediately after rain storms; it can clog the gills of aquatic life and smothers the bottom of the creek bed.

The Water Quality Monitoring Group allows proactive volunteers, such as yourself, to monitor your local stream and determine your stream's health. Your data can also be shared with other volunteer monitoring groups across the State.

Volunteer groups shall monitor a specific stream segment for a one year period, with the option to renew the agreement after each year is complete.

Volunteer groups will be provided with enough monitoring equipment for a one year period and will then return equipment back to Town of Wake Forest.

- Monitoring kits include equipment to monitor the following parameters: dissolved oxygen, pH, temp, nitrogen, phosphorus, temperature, and turbidity.
- Benthic macro invertebrate equipment includes a D-frame dip net, a bucket, two (2) sorting trays, identification key, tweezers, and two (2) magnifying bug boxes.
- Safety vests and field data sheets to record monitoring results will be provided.

Over the course of the one year monitoring period, groups are encouraged to monitor their site for the chemical parameters ten to twelve times and Coliform bacteria three (3) times; groups are encouraged to survey the benthic macro invertebrates once a year (in July or August).

After each monitoring date, groups shall submit their recorded data to Engineering staff.

- Monitoring data will be posted in a database available online to compare data with other volunteer monitoring groups across the State.

Any pollution sources identified by the groups will promptly be investigated by Town staff to ensure the pollution source is eliminated.

The Town is not responsible for injury to persons or property resulting from Volunteer Monitoring activities. A waiver of liability must be signed prior to start of program.

Smith Creek
Water Quality Monitoring Group

SMITH CREEK WATER QUALITY MONITORING GROUP AGREEMENT

____ hereby agrees to monitor
(Volunteer Group Name)

__________________________ as part of the Smith Creek Water Quality Monitoring Group.
(Location of section)

The minimum responsibilities that accompany monitoring the stream segment are as follows:

1 Monitor the stream over the course of one (1) year and collect water quality data for a minimum of ten to twelve times throughout the year. Water quality data consists of chemical testing parameters included in testing kits provided by the Town of Wake Forest.
2 Monitor the stream over the course of one (1) year and collect data one (1) time for benthic macro invertebrate sampling. Sampling equipment will be provided by the Town. Benthic macro invertebrate monitoring should be done between July and August.
3 Keep complete and accurate records of all data collected using Field Data Collection Sheets, which are provided by the Town. Field Data Collection Sheets should be emailed to the Town within 72 hours of the completion of monitoring activities. For accurate data, groups must monitor at the same location consistently.
4 If groups wish to discontinue their data collection, all monitoring equipment shall be returned to the Town.

We understand all of the requirements set forth for volunteer monitoring and agree to monitor the

Smith Creek at this specific location: __________________________.
(Landmark, road intersection)

If available, the GPS coordinates are N ___° ___' ___.___" and W ___° ___' ___.___" for the

period of one (1) years beginning on ___________________ with the option to renew
(Date)
my agreement after the year is complete.

Contact Person (print): __________________________ Phone Number: _______________

E-Mail: ____

Address (print): ____
(Street Address)

Smith Creek
Water Quality Monitoring Group

Town of
Wake Forest
North Carolina

LIABILITY WAIVER

I, the undersigned, being the volunteer involved in the Town of Wake Forest Smith Creek Water Quality Monitoring Group (hereinafter referred to as the Group) or being the parent or legal guardian of such a volunteer in the Group, in consideration of my or another's participation in the Group, I hereby, for myself and any volunteer for whom I am a parent or legal guardian release, discharge, hold harmless, and forever acquit the Town of Wake Forest, Neuse River Foundation, or other local sponsors, and their officers, agents, representatives and employees from any and all actions, causes of action, claims or any liabilities whatsoever, known or unknown now existing or which may arise in the future, on account of or in any way related to or arising out of my participation in the Group. Further, I assume all liability of any non-participants who accompany me.

I understand that I am a volunteer for all purposes, including workers compensation, and am not an employee of the Town of Wake Forest, Neuse River Foundation, or other local sponsors, and their officers, agents, representatives and employees, and as such they are not responsible for injury or death of myself and any volunteer for whom I am a parent or legal guardian which may occur while acting as a volunteer.

Participant's name (please print): ______________________

Participant's signature: ______________________

Participant's age: ________

Signature of participant's parent or legal guardian (if under 18): ______________________

Date: ____________

Town of Wake Forest North Carolina

Smith Creek
Water Quality Monitoring Group

Holly E. Spring, Office 554-3158, Nextel 795-2034

Calendar of Events

Date	Outing Detail	Time	Location
Thursday, August 07, 2008	The Redwoods Group stream clean up (independent clean up)	9am - 3pm	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, August 09, 2008	**Official Program Start Date**- Overview, waivers, how to identify macro invertabrates and why they are indicators of water quality	9am - noon	Smith Creek Soccer Ctr
Saturday, September 13, 2008	**Monitoring 101**- This training session will discuss what different stream colorations to look for, how to use litmus paper vs the YSI 650 meter to test various parameters	9am - noon	Burlington Mills/Ligon Mill Site
Saturday, October 11, 2008	**Smith Creek Stream Clean Up Day**	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, November 08, 2008	**Erosion 101**- We will be talking about natural vs accelerated erosion and how to use the turbidity meter	9am - noon	Burlington Mills/Ligon Mill Site
Saturday, December 13, 2008	**Stream Characteristics**- how to identify pools, riffles, runs, classifying stream type and the health of the stream	9am - noon	Smith Creek Soccer Ctr
Saturday, January 10, 2009	**Stream Education**- use of the enviroscape model, importance of buffers, pamphlets/handouts and things we can do to help, winter water safety	9am - noon	Smith Creek Soccer Ctr, TH Board Room (depending on temp)
Saturday, February 14, 2009	**Valentine's Day Reservoir paddle and sampling**- We will be learning how to use the sechi disk, pH, temp, wildlife viewing	9am - noon	WF Reservoir, meet in parking lot
Saturday, March 14, 2009	Monitoring, TBD	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, April 11, 2009	**Stream Clean Up Day**	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, April 25, 2009	**Arbor Day/Earth Day Celebration**- Tree give away and stream/eco education	9am - noon	WF Town Hall
Friday, May 09, 2008	Monitoring, TBD	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, June 13, 2009	Monitoring, TBD	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, July 11, 2009	Monitoring & Macro count	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill
Saturday, August 08, 2009	Monitoring, 1 year wrap up, results, survey	9am - noon	Smith Creek Soccer Ctr, Burlington Mills/Ligon Mill

Smith Creek
Water Quality Monitoring Group

Stream Survey Data Sheet

Stream Location:

____

Sample Number __________ of ___________

Date________________

Time________________

Weather_____________

Please make sure you have the forms on file prior to starting:

- ___ Waiver form
- ___ Monitoring agreement
- ___ Current contact data

Please forward a copy of this form via email to Holly E. Spring at hspring@wakeforestnc.gov or drop off/mail to:

Town of Wake Forest
c/o Holly E. Spring
Engineering Department
401 Elm Ave
Wake Forest, NC 27587

If you have any questions please contact me at 919-554-3158.

(Required)

Type of monitoring (place a ✓ on the appropriate line):

___________ Visual monitoring

___________ Macro invertebrate count

___________ Chemical test (check which parameters taken)

_____Temperature
_____pH
_____Dissolved Oxygen
_____Nitrogen
_____Phosphorus
_____Turbidity
_____Conductivity

___________ Stream clean up

(Optional)

You should select a riffle where the water is not running too fast (ideal depth is 3-6 inches), and the stream bed consists of coddle sized stones or larger if possible. Try to select a 3 square foot area if possible.

Width of study area

Pool section ___________

Riffle section __________

Depth of Study area

Pool section ___________

Riffle section __________

Speed of stream flow (velocity in meters/sec) ________________

Use tennis ball method or multi parameter unit

Water Temp (degrees Celsius) ________________

Smith Creek
Water Quality Monitoring Group

Visual Stream Diagnosis

"How can I tell what is wrong with my stream?" Just like diagnosing a person or pet that is sick, you take all the symptoms and signs together and try to hazard a guess. These tables are to help you know what kind of problems you might have in your area and the obvious signs of those problems. Read each table several times allowing you to get a feel for threats to streams. You may want to take these tables with you when you visit your stream.

Characteristics of Surrounding Area Draining Into Stream

Forests	Check for sedimentation (cloudy or muddy water) from erosion caused by logging, road building, or any clearcutting.
Farmland (crops, pastures, feedlots)	Check for excessive algae growth caused by fertilizer or manure draining into stream. Also watch for sedimentation caused by poor farming practices and possible pesticides.
Urban Settings	Urban run-off can carry with it all sorts of pollution including metals, salts, chemicals, and oil. Insect counts may indicate the presence of one of the above, but chemical analysis may be needed to pinpoint it.
Industries	Because the variety of by-products of industry, the stream should be tested for both organic and toxic substances. Keep an eye out for excessive algae and absence of animal life, such as insects and fish.
Sewage (treatment plants or pipelines)	Look for organic pollution indicated by absence of some aquatic organisms and/or extreme abundance of others.
Mining	Check for sedimentation and acid drainage. Acid drainage can be detected by a low pH. A yellowish-orange deposit may be present on bottom.
Construction	Land disturbing activities such as development and road building are the leading cause of erosion and sedimentation, so watch for cloudy or dirty water.

Residential (homes)	Lawn fertilizer, detergents used for washing clothes or cars, oils drained from autos and grass clippings are common forms of residential pollution. Keep an eye open for excessive algae growth, white foam greater than 3 inches high, color sheet on surface or absence of organisms in select counts.

Physical Indicators of Water Pollution

Color of Stream

Green	If the stream is excessively green, this could be an indication of nutrients being released into stream, feeding algae. What To Do: Check watershed for possible fertilizer or manure run-off areas.
Orange-red	Orange to red deposits could be cause by acid drainage. What To Do: Check watershed for mining and watch for industrial waste draining into the stream.
Light brown (muddy or cloudy)	Sedimentation deposition caused by erosion. What To Do: Search upstream for disturbed ground left open to rainfall. Remember, if the source is a drainpipe, don't stop there.
Yellow coating on stream bed	Indication of sulfur entering the stream. What To Do: Check upstream for industrial waste or coal-using operation.
Multi-color reflection	Indicates oil floating in stream. What To Do: Check closely upstream for source – waste oil may have been dumped along the stream.
Yellow-brown to dark-brown water	Acids released from decaying plants What To Do: Naturally occurs each fall when dead leaves collect in the stream. Also common in stream draining marsh or swampland.
White, cottony masses on stream bed	Could be "sewage fungus" What To Do: The presence of this growth indicates sewage or other organic pollution.

Stream Odor:

Rotten egg odor	Indicates sewage pollution. Odor may also be present in marsh or swampy land.
Musky odor	May indicate presence of untreated sewage, livestock waste, algae or other conditions.
Chlorine	This may mean that a sewage treatment plant is over chlorinated their effluent.
Chemical	May indicate the presence of an industrial plant or the spraying on nearby agricultural land.
Foaming	When white and greater than 3 inches high, it may be due to detergents. What To Do: Check upstream for industrial or residential waste entering the stream.

Fish as Biological Indicators of Water Quality

Odd Behavior	Jumping out or non-responsive action of fish may indicate toxic substance in the stream. What To Do: Chemical analysis is needed to find the source, but check upstream to see where it begins.
Absence of Fish	This is a good indication of a badly stressed stream. The cause could be urban run-off, sewage seepage or toxics entering the stream. What To Do: Chemical analysis is needed to find the source. Again, check upstream to find where it begins.

Visual Monitoring

(place a on the appropriate line that matches the condition)

Water Appearance

______ Scum
______ Foam
______ Muddy
______ Clear
______ Tea
______ Milky
______ Oil sheen
______ Brownish
______ Other

Stream Bed Coating

______ Orange/red
______ Yellowish
______ Black
______ Brown
______ Gravel
______ None

Odor

______ Rotten egg
______ Musky
______ None
______ Other

Bank Cover

Look at the stream bank on both sides and visually determine % of ground cover in several spots (if different mark left bank or right bank looking downstream)

______ Good (70-100% of bank soil covered by plants, rocks, logs)

______ Fair (30-70% of bank soil covered by plants, rocks, logs)

______ Poor (0-30% of bank soil covered by plants, rocks, logs)

Stability of Stream Bank

Stand on the bank and determine if the material sinks below your feet in several locations (5-10)

______ no spots ______few spots ______many spots

Bed Composition of Riffle

Use sand cards to determine size

_____ % silt
_____ % sand (1/16-1/4")
_____ % gravel (1/4- 2")
_____ % cobbles (2-10")
_____ % boulders (> 10" stones)

Algae color
_____ light green
_____ dark green
_____ brown coat
_____ matted on stream bed
_____ hairy looking

Algae location
_____ widespread
_____ localized
_____ % bedcover

Land use near stream reach/section

(place a ✓ on the appropriate line that matches the condition, if more than one use is nearby check all that match)

_____ stores/commercial
_____ woods
_____ farm fields (cows/horses)
_____ agriculture (crops)
_____ other:

____

_____ factories/industrial
_____ residential
_____ golf course/playing field
_____ construction

Please answer the following questions regarding point source pollution with a yes or no

_______ Are there any direct discharge pipes (stormwater, grey water, other) into creek?

If yes, note pipe size, qty, type (RCP, plastic, other), discharge color:

Pipe size (interior diameter in inches) _______

Quantity_______

Type (RCP-concrete, HDPE-black plastic, PVC- white)_______

Discharge Color __________

_______ Did you test below and above discharge to determine any chances in water quality?

If yes, please note differences:

	Upstream	Downstream
Temp	__________	__________
pH	__________	__________
DO	__________	__________
Nitro	__________	__________
Phos	__________	__________
Turbidity	__________	__________
Conductivity	__________	__________

Water elevation drop

Note structures causing water level differences of 1 foot or more by placing a ✓ on the appropriate line that matches the condition, if more than one condition exists in the reach/section check all that apply

______ Waterfalls (including rock weirs in stream restorations, stream crossings, etc...)
______ Down trees, log jams
______ Beaver dams
______ Pipe structures that have undermined
______ None
______ Other:
____

Barrier to fish passage

Note structures limiting/prohibiting fish passage by placing a ✓ on the appropriate line that matches the condition, if more than one condition exists in the reach/section check all that apply

______ Waterfalls (including rock weirs in stream restorations, stream crossings, etc...)
______ Down trees, log jams
______ Beaver dams
______ Pipe structures that have undermined
______ None
______ Other:
____

Smith Creek
Water Quality Monitoring Group

INSECTS AND STREAM QUALITY

How clean is your stream?

You can answer that question by counting the insects in your stream. Many stream-dwelling organisms are sensitive to changes in water quality. Their presence or absence can serve as indicators of environmental conditions. Macro invertebrates (visible, spineless animals), especially insects, are easy to find. By following the technique below and filling out the Aquatic Survey Sheet, you can diagnose your stream's water quality.

Kick-Net

The equipment required includes a kick-net (a fine mesh net with a supporting pole on each side) or an old window screen with no holes, forceps, a clear plastic container, several jars for collecting, and a microscope or magnifying glass.

1. Select a riffle typical if the stream, that is, a shallow, fast-moving area with a depth of 3 – 12 inches and stones which are cobble-sized (2 – 10 inches) or larger.

2. Place the kick-seine or screen at the downstream edge of the riffle. Be sure that the bottom of the seine or screen fits tightly against the stream bed (you may want to use rocks to hold the net down tightly), so no insets can escape along this point. Also, don't allow any water to flow over the screen top. This too could allow insects to escape.

3. Disturb the streambed for a distance of 3 feet upstream of the kick-seine. Brush your hands over all rock surface to dislodge any attached insects. Stir up the bed with hands and feet until the entire 3 foot square area has been worked over (Remember to be careful of your hands. Watch for objects that might cut). All detached insects will be carried into the net. For 60 seconds, and no longer, kick the streambed with a sideways motion of the net. This may bring up a few ground dwellers.

4. When step 3 is completed, remove the net with a forward scooping motion. The idea is to remove the net or screen without allowing any of the critters to be washed from its surface.

5. Place the new on a flat, light-colored area. Using forceps, pick all of the creatures from the net and place them in a pan, or just wash the creatures into a light-colored bucket where they may be easily seen. Any creatures moving, even

if it looks like a worm, is part of the sample. (Do not miss snails and clams.) Look closely since most of these organisms are only a fraction of an inch long.

6. Once all animals have been removed from the net (excluding any fish or other vertebrates – throw these back quickly so they might survive the stress of being out of their habitat), count the total number. Then separate them into look-alike groups. Use body shape and number of legs and tails primarily since the same family can vary some in size and color.

7. If the stream seems to have a problem, for example, no bugs are found, take a quick second sample from another spot, preferably a riffle. If your results are similar, you might want to check another spot about a quarter mile upstream. When you find a place where the variety of benthic creatures is greater and the numbers are more balanced, then you know the problem occurs between that spot and where you last tested downstream.

8. Sometimes, it can be difficult to locate a riffle. For example, in an area where there is excessive sand, boulders and rocks are often completely covered. In these cases, remember that a riffle is an area of turbulence. It may be composed of rocks, logs, or even an old car! Look for large stationary objects. Things which have "weathered" in the stream a while. (The critters need time to make these objects home.) Then kick around them much as you would rocks. However, if the substrate is covered with sand or composed entirely of bedrock and a "kickable" riffle does not exist, you can use the bank habitats. For example, place your net downstream of a submerged tree or grass roots and kick in and around them. Make sure it is an area where water is flowing or there is current.

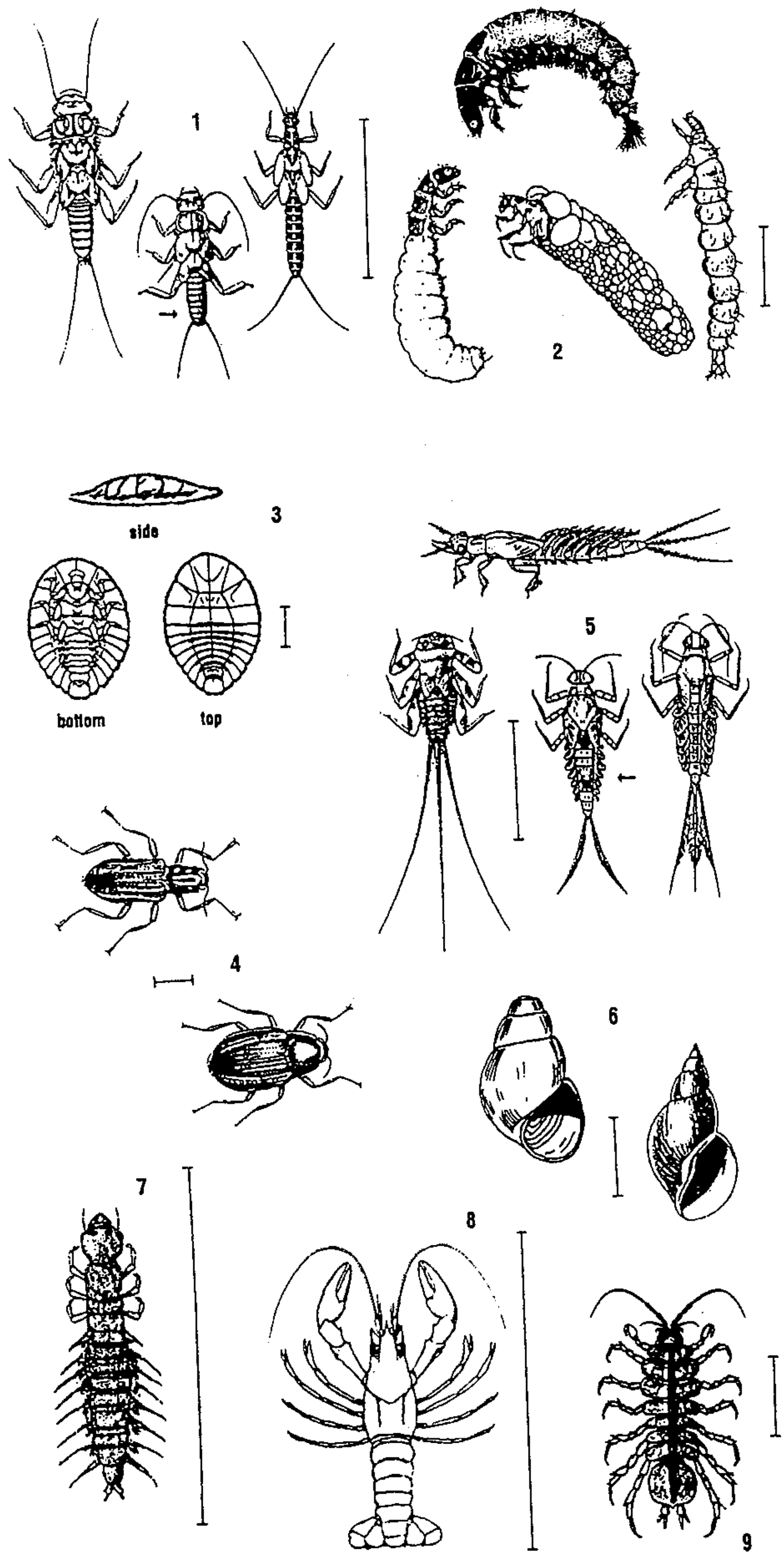
Sweep Net Survey

Most people are familiar with the dip nets used for fishing, A sweep net is similar in construction, but the mesh of the net is smaller. In fact, the net mesh found on a sweep net is smaller than the mesh net used on most kick-nets.

If your group has the money, you can order sweep nets from scientific supply houses, however, a very adequate net can be simply and inexpensively constructed by arranging screen mesh over an old dip net frame. This net will not be ideally correct, but it will be useful for collecting a wide variety of creatures. **Small aquarium dip nets can be used for sampling an area many times in a short period (i.e. student sampling over several periods during a week).**

To perform a sweep net survey, take your net and sweep around the banks of your stream. Sweep in and around tree roots and vegetation. Then, stir the sediment near the stream bank with your foot and use the sweep net to scoop up the creatures jarred loose. Dragonflies, damselflies, mayflies, and snails will often be found in a sweep net sample.

Stream Invertebrates



Bar line indicate relative size

Group One Taxa

Pollution sensitive organisms found in good quality water.

1 **Stonefly Order Plecoptera.** 1/2" to 1 1/2", 6 legs with hooked antenna, 2 hair-line tails. Smooth (no gills) on lower half of body (see arrow).

2 **Caddisfly: Order Trichoptera.** Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock, or leaf case with its head sticking out. May have fluffy gill tufts on underside.

3 **Water Penny: Order Coleoptera.** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.

4 **Riffle Beetle: Order Coleoptera.** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 **Grilled Snail: Class Gastropoda.** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.

6 **Mayfly: Order Ephemeroptera.** 1/4" to 1", brown, moving, plate-like or feathery gills on the sides of lower body (see below), 6 large hooked legs, antennae, 2 or 3 long hair-like tails. Tails may be webbed together.

7 **Dobsonfly (hellgrammite): Family Corydalidae.** 3/4" to 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails, and 2 pairs of hooks at back end.

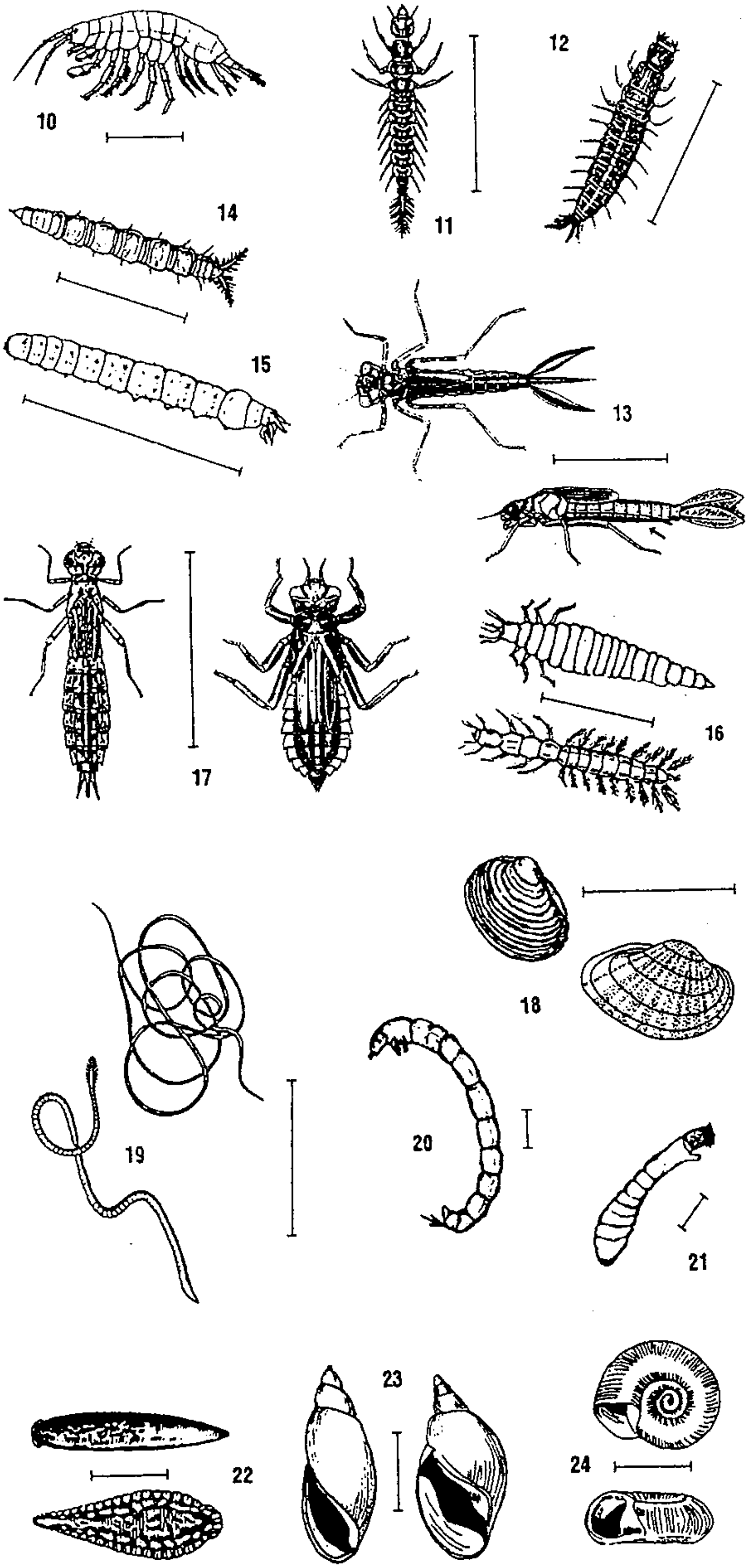
Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

8 **Crayfish: Order Decapoda.** Up to 6", 1 large claws, 8 legs, resembles small lobster.

9 **Sowbug: Order Isopoda.** 1/4" to 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Source: Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878-2983. (800) BUG-IWLA



Bar line indicate relative size

Group Two Taxa

Somewhat pollution tolerant organisms can be in good or fair quality water.

10 **Scud: Order Amphipoda.** 1/4", white to gray, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 **Alderfly Larva: Family Sialedae.** 1" long. Looks like small Hellgramite but has long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 **Fishfly Larva: Family Cordalidae.** Up to 1/2" long. Looks like small hellgramite but often a lighter reedish-tan color, or with eyllowish streaks. No gill tufts underneath.

13 **Damselfly: Suborder Zugoptera.** 1/2" to 1" large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 **Watersnipe Fly Larva: Family Atherici-dae (Atherix).** 1/4" to 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 **Crane Fly: Suborder Nematocera.** 1/3" to 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 **Beetle Larva: Order Coleoptera.** 1/4" to 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 **Dragon fly: Suborder Anisoptera.** 1/2" to 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 **Clam: Class Bivalvia.**

Group Three Taxa

Pollution tolerant organisms can be in any quality of water.

19 **Aquatic Worm: Class Oligochaeta.** 1/4" to 2", can be very tiny, thin worm-like body.

20 **Midge Fly Larva: Suborder Nemato-cera.** Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 **Blackfly Larva: Family Simulidae.** Up to 1/4", one end of body wider. Black head, suction pad on other end.

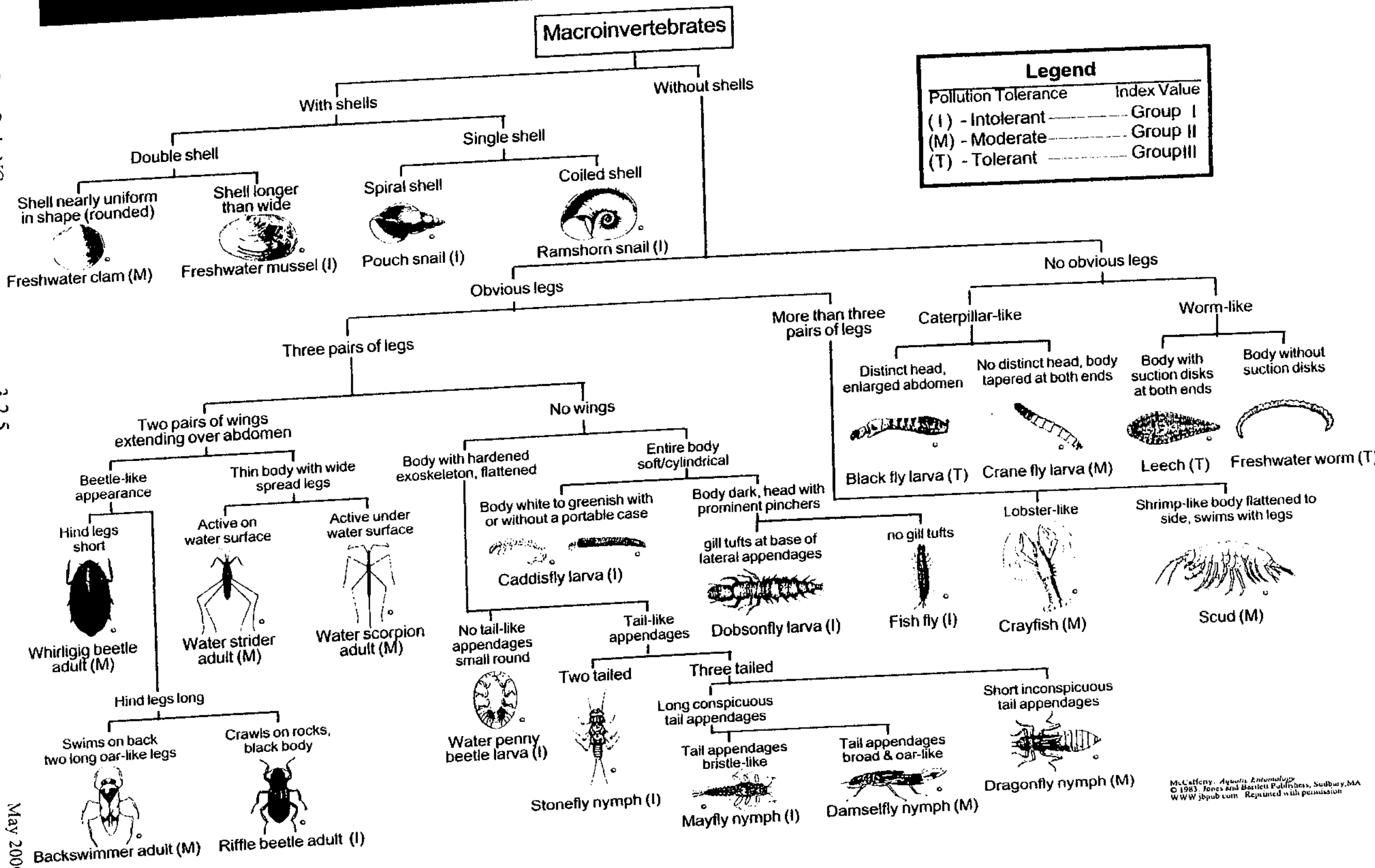
22 **Leech: Order Hirudinea.** 1/4" to 2", brown, slimy body, ends with suction pads.

23 **Pouch Snail and Pond Snails: Class Gastropoda.** No operculum. Breath air. When opening is facing you, shell usually open to left.

24 **Other Snails: Class Gastropoda.** No operculum.Breath air. Snail shell coils in one plane.

Key To Common Macroinvertebrates

Found at Fews Ford, Eno River State Park



Aquatic Life

In this section, we will be searching the stream for macro invertebrates who are indicators of water quality. Use the leaf pack cards, macro books and kicknets to find organisms record your results by tolerant level. This should be done in 3 times in a riffle section of the creek with in a 24 foot area. For each test, multiply the groups I, II, and III by the appropriate value, then add up to get the stream index value. This value then gives us a range for water quality and stream support value based on your field counts.

Excellent (> 22)	Fair (11 - 16)
Good (17 - 22)	Poor (< 11)

Circle the macro species that was found

Group I- intolerant	Group II- moderate	Group III- tolerant
Caddis fly larvae	beetle fly larvae	aquatic worms
Dobson fly larvae	clam	black fly larvae
Mayfly nymph	crane fly larvae	leech
other snails	crayfish	midge larvae
riffle beetle (adult)	damselfly nymph	pouch snail
stonefly nymph	dragonfly nymph	
water penny larvae	scud	

Count number of circles from each group and write number on each line, then multiply by the correct number and add up to get the stream index value

	Group I		Group II		Group III
	________		________		________
Tolerant Multiplier	x 3 =		x 2 =		x 1 =
	________	+	________	+	________

Sum of tolerant multipliers = ________ Stream Index value

(place a · on the appropriate line that matches the condition, if more than one group is nearby check all that match)

Fish	Crayfish
______ Scattered individuals	______ scarce
______ Scattered schools	______ abundant

Please use the space below to describe other interesting finds (turtles, frogs, great blue heron, hawk, deer, snakes, spiders, etc...):

____
____
____
____
____
____
____
____
____
____
____
____
____
____
____
____
____
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____
____
____

Chemical and Physical Parameters

Sample ______ of ________

Date ________________

Time taken: _________

Location ____

Weather today __________________________

Rain fall within 24 hours, if so how much? ________________

48 hours? _______________

72 hours? _______________

Air Temperature (degrees C/degrees F) ____________

Water Temperature (degrees C/degrees F) ____________

pH ___________________

Testing Method: ____________

DO ___________________ mg/L

Notes:

Conductivity ___________

Turbidity ______________

Nitrogen _______________

Phosphorus _____________

Stream Flow ____________ cfs

Litter Cleanup

Date ______________

Length of stream cleaned ________________________

Group ____

Number of participants __________________________

Describe % and type of litter collected around stream

____

____

____

Average number of small and large items collected

Small, paper, trash	cans and bottles	tires, carts, etc...
_____ 0 - 5	_____ 0 - 5	_____ 0 - 5
_____ 5 - 10	_____ 5 - 10	_____ 5 - 10
_____ 10 - 50	_____ 10 - 50	_____ 10 - 50
_____ 50 +	_____ 50 +	_____ 50 +

Total number of trash bags _______________

Unusual items

____

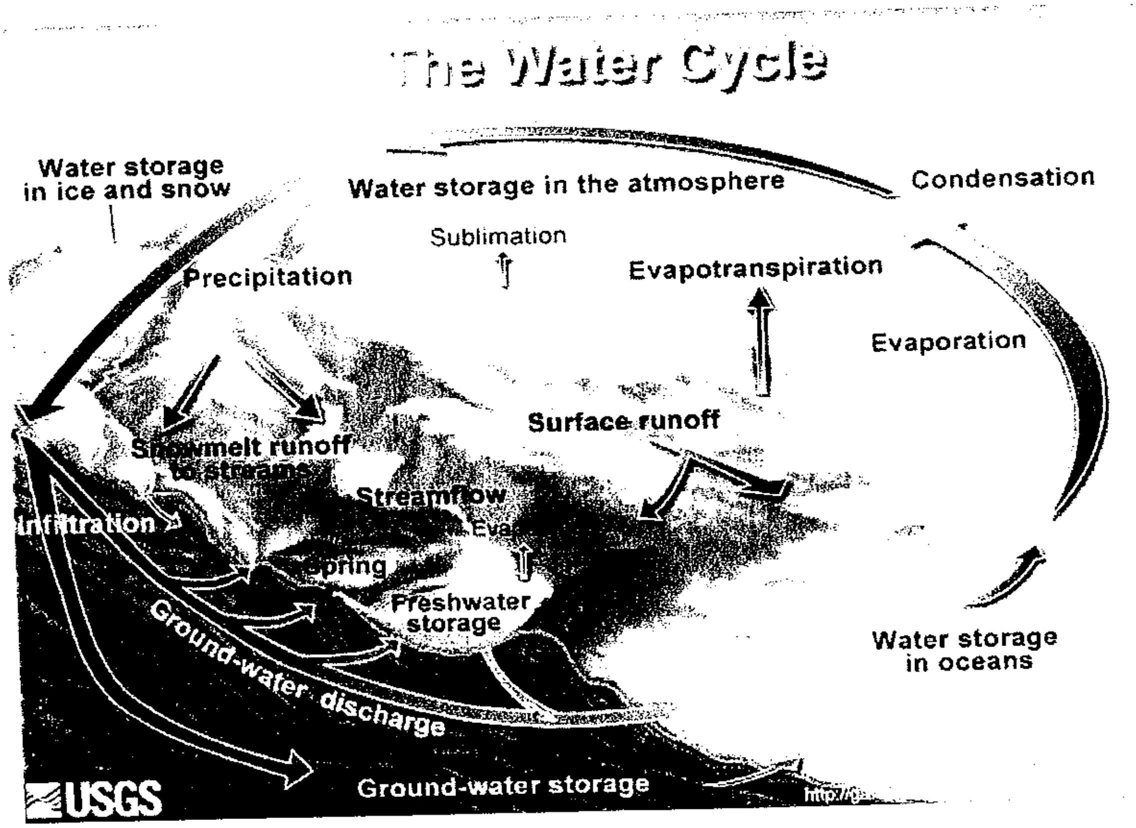
____

____

Smith Creek
Water Quality Monitoring Group

Water 101

Water is the fundamental building block of all life. Without it we cannot survive. We get our water from the foods we eat and the things that we drink. Humans are made of up 55-78% water and the earth is made up of 71% water. The amount of water in all its forms (ice, water, and water vapor) on earth is 1,360,000,000 cubic kilometers or 326,000,000 cubic miles. This volume never changes but is rotated thru the hydrologic cycle as shown below.



Approximately 0.02% of the earth's water is available for our use. So, if we don't pick up our garbage, motor oil, pet waste or any other pollutants that are on our soil, in our streams or down the drain it will eventually contaminate our water supply. The fresh water will eventually reach the ocean and that can be contaminated too.

Play a River Runs thru it game...

Streams 101

Now that we know water and our affects on the water cycle, let's talk about creeks, streams, and rivers.

Streams functions are to:

1. transport water
2. transport sediment
3. habitat (aquatic and terrestrial)
4. recreation
5. aesthetics
6. safe water supply

Here are some definitions that we will need to know:

Creek - small to medium sized natural stream. Sometimes navigable by motor craft and may be intermittent.

Stream - a body of water with a current, confined within a bed and stream-banks. Streams are important as conduits in the water cycle, instruments in groundwater recharge, and they serve as corridors for fish and wildlife migration. The biological habitat in the immediate vicinity of a stream is called a riparian zone

River - A large natural stream, which may be a waterway.

Neuse Buffer Rule – a 50 foot protected riparian zone on each side of a body of water measured from the top of bank. No mowing, little clearing and no filling is allowed in this area.

Riparian Zone - is the interface between land and a stream. It may be natural or engineered for soil stabilization or restoration. These zones are important natural biofilters, protecting aquatic environments from excessive sedimentation, polluted surface runoff and erosion. They supply shelter and food for many aquatic animals and shade that is an important part of stream temperature regulation. When riparian zones are damaged by construction, agriculture or silviculture, biological restoration can take place, usually by human intervention in erosion control and revegetation.

Top of Bank – is the active water level

Ephemeral- streams that flow only during and immediately after precipitation. These streams are not protected under the Neuse Buffer Rule.

Intermittent – streams that only flow for part of the year and is marked on topographic maps with a line of blue dashes and dots. These streams quickly fill during rains, and there may be a sudden torrent of water after a thunderstorm begins upstream. These streams are protected by the Neuse Buffer Rule.

Perennial – also known as a blue-line stream is one which flows for most or all of the year and is marked on topographic maps with a solid blue line. These streams are protected under the Neuse Buffer Rule.

Spring - the point at which a stream emerges from an underground course through unconsolidated sediments or through caves. A stream can, especially with caves, flow aboveground for part of its course, and underground for part of its course.

Source - the spring from which the stream originates, or other point of origin of a stream.

Headwaters - the part of a stream or river proximate to its source. The word is most commonly used in the plural where there is no single point source.

Confluence - the point at which the two streams merge. If the two tributaries are of approximately equal size, the confluence may be called a fork.

Run - A somewhat smoothly flowing segment of the stream.

Pool - A segment where the water is deeper and slower moving. It is a refuge place for fish during droughts and also provides a rest stop and food area for fish.

Riffle - A segment where the flow is shallower and more turbulent. These areas increase oxygen levels in water, have a highly diverse substrate and habitat including macros.

Channel - A depression created by constant erosion that carries the stream's flow.

Floodplain - Lands adjacent to the stream that are subject to flooding when a stream overflows its banks. There is no filling within the 500 year floodplain in Wake Forest.

Stream bed - The bottom of a stream.

Gauging station - A point of demarkation along the route of a stream or river, used for reference marking or water monitoring.

Thalweg - The river's longitudinal section, or the line joining the deepest point in the channel at each stage from source to mouth.

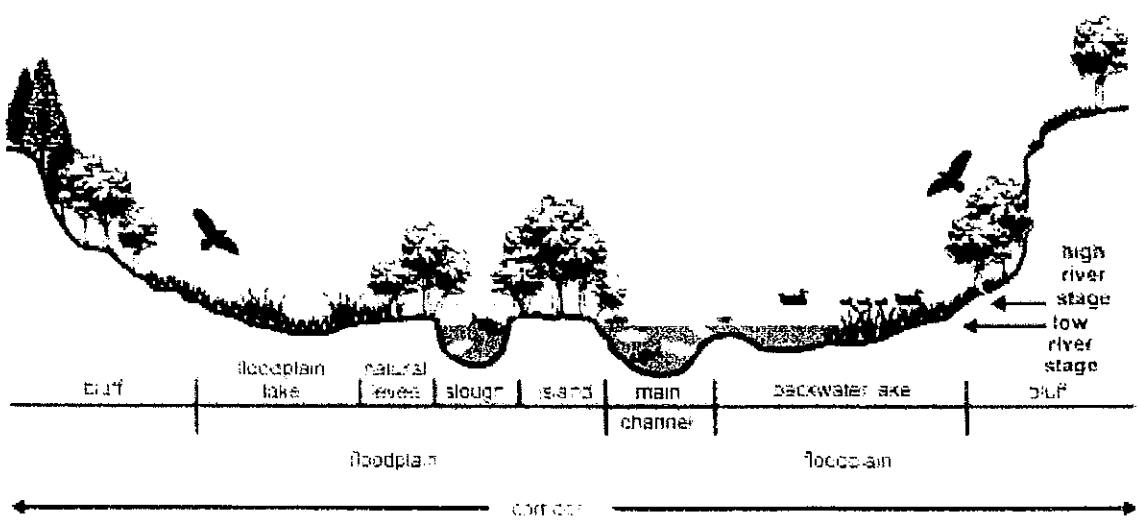
Wetted perimeter - The line on which the stream's surface meets the channel walls.

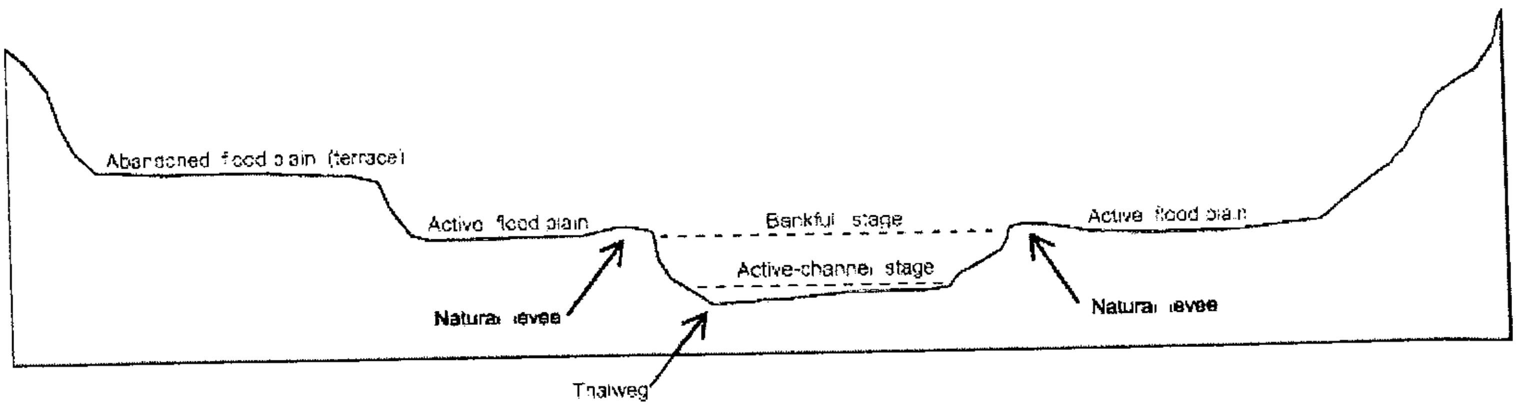
Nickpoint - The point on a stream's profile where a sudden change in stream gradient occurs.

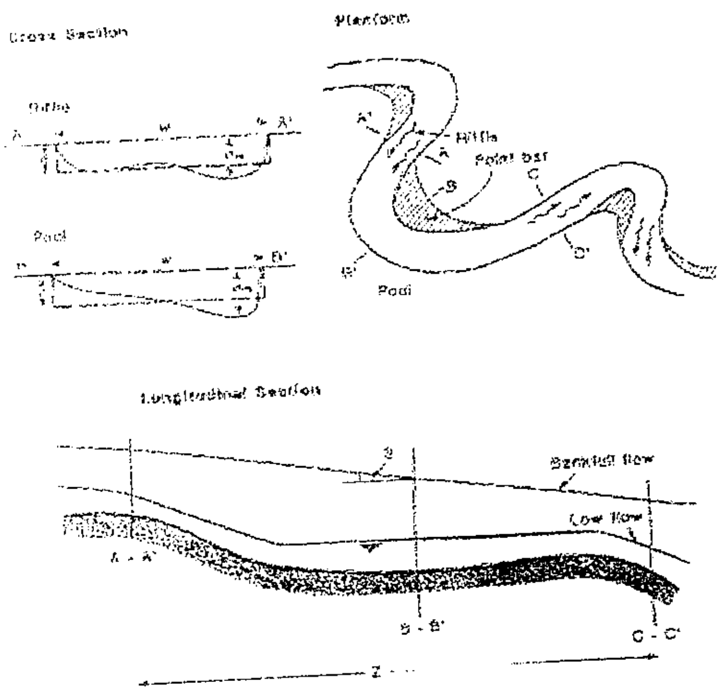
Waterfall or cascade - The fall of water where the stream goes over a sudden drop called a nickpoint; some nickpoints are formed by erosion when water flows over an especially resistant stratum, followed by one less so. The stream expends kinetic energy in "trying" to eliminate the nickpoint.

Mouth - The point at which the stream discharges, possibly via an estuary or delta, into a static body of water such as a lake or ocean.

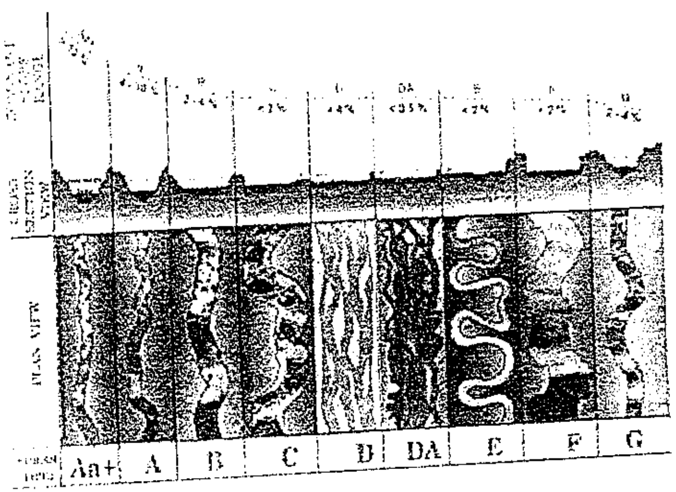
We will be looking at Pools, riffles and runs along with buffers and flood plains for most of the monitoring.

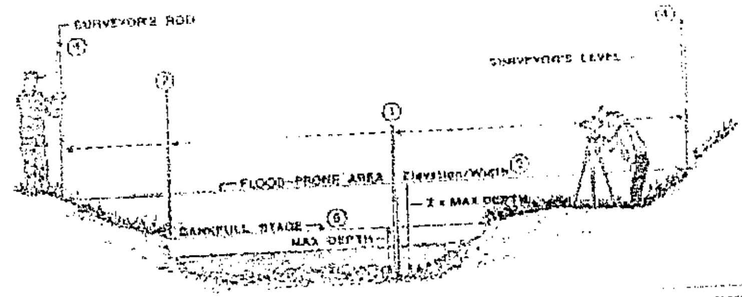


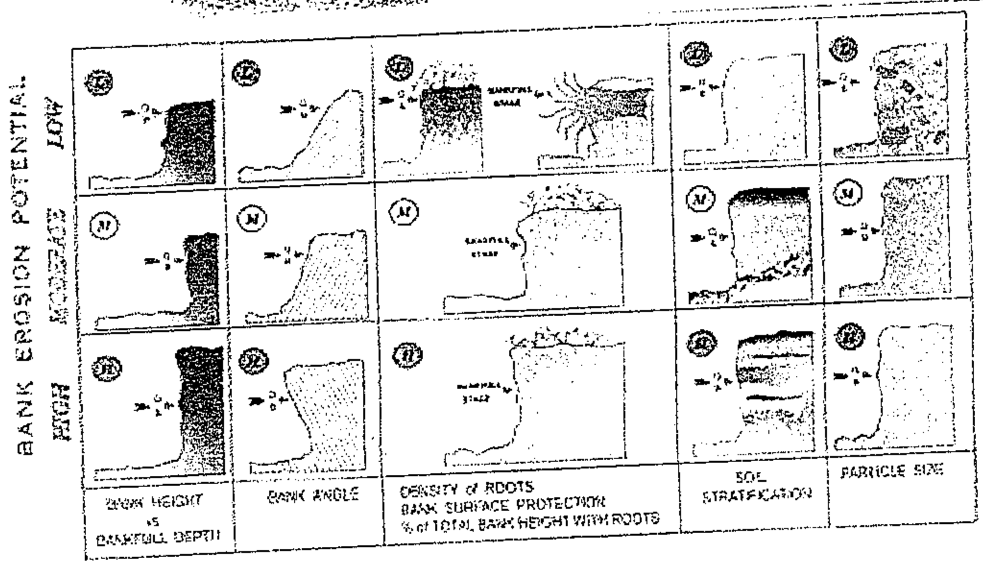

Abandoned flood plain (terrace)
Active flood plain
Bankfull stage
Active flood plain
Active-channel stage
Natural levee
Natural levee
Thalweg

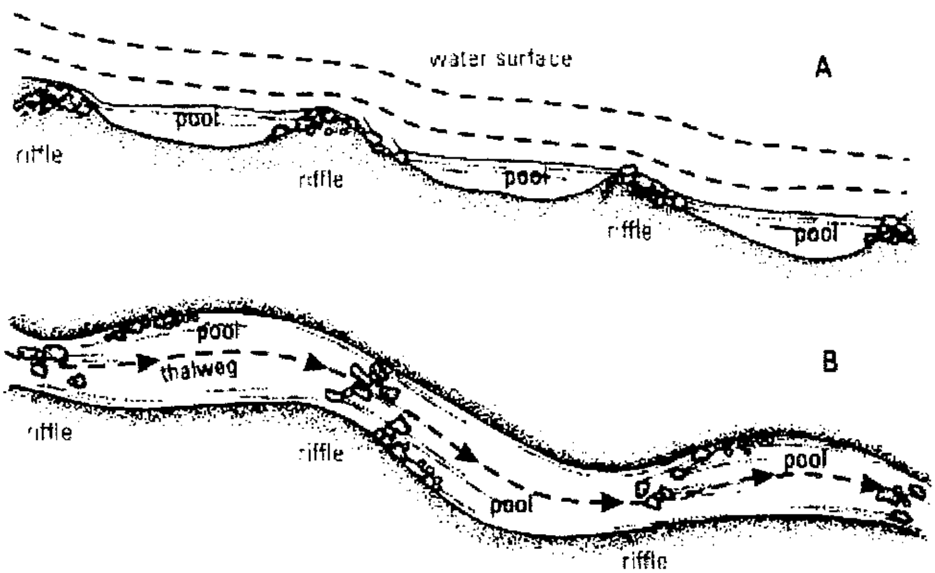


LONGITUDINAL, CROSS-SECTIONAL and PLAN VIEWS of MAJOR STREAM TYPES








water surface
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pool
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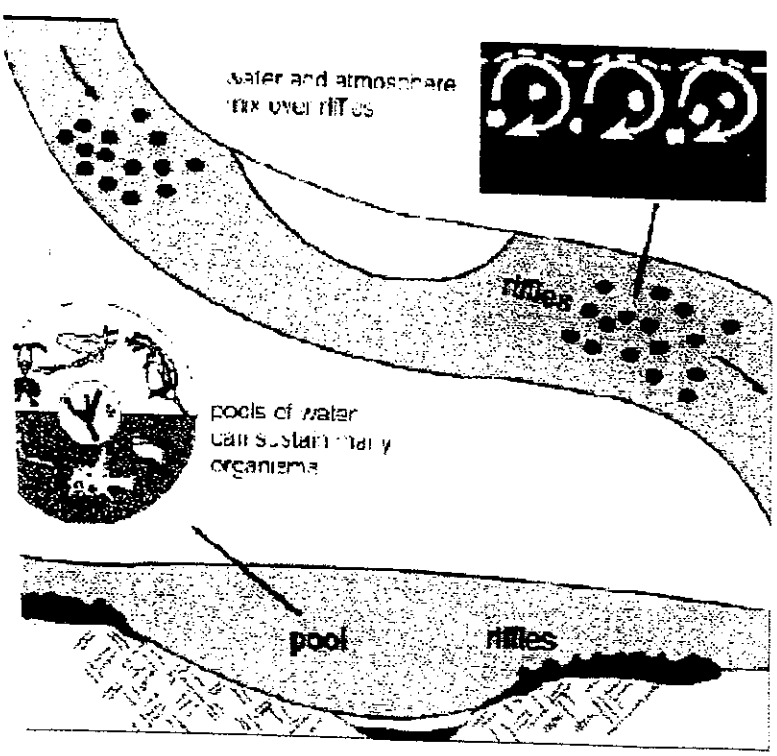
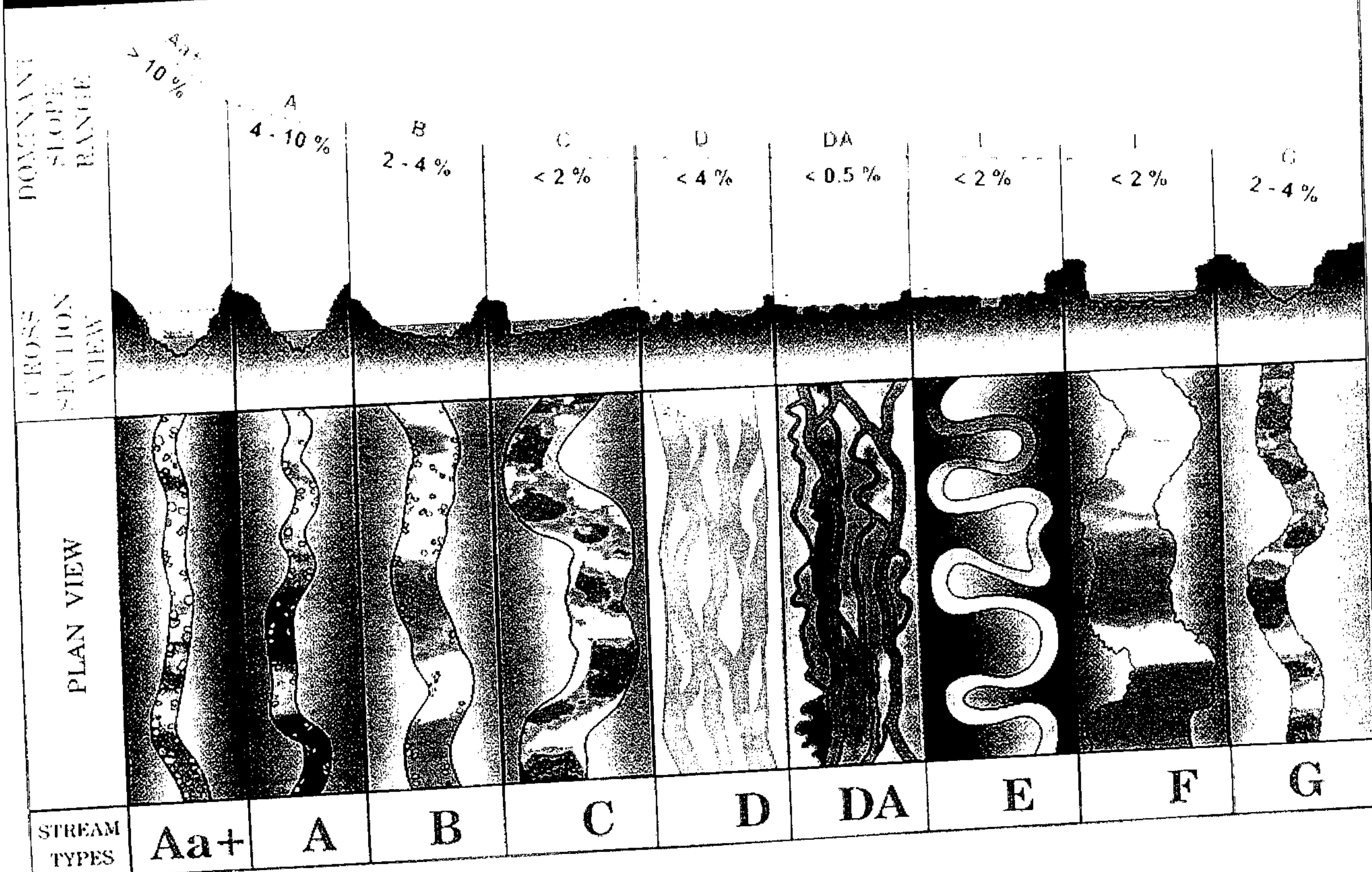
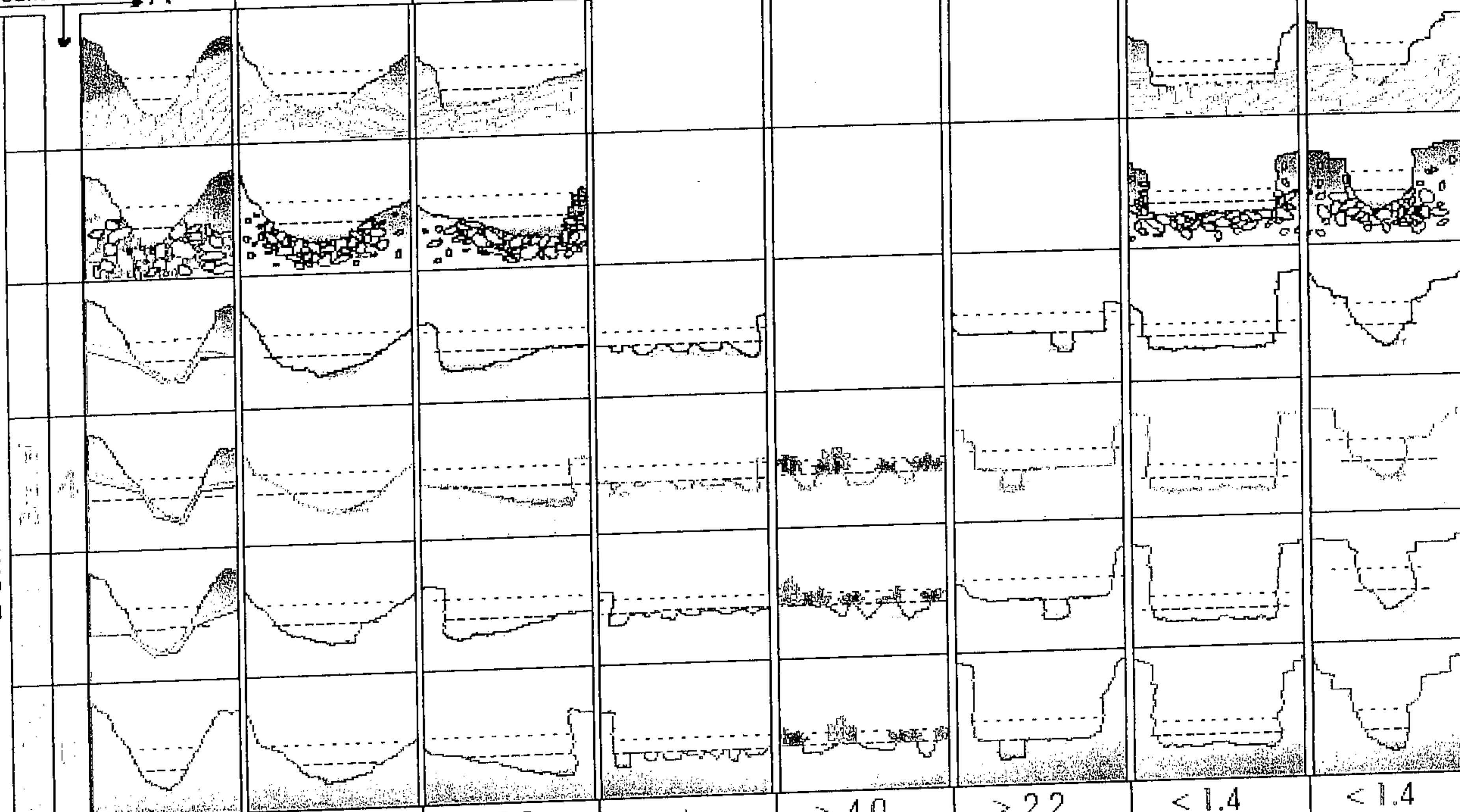
riffle


riffles
pool
riffles

Rosgen Stream Classification System



Dominate Bed Material



Stream TYPE	A	B	C	D	DA	E	F	G
Entrchmnt.	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	> 1.5	> 1.2	> 1.2
H_2O Slope	.04-.099	.02-.039	< .02	< .04	<.005	< .02	< .02	.02-.039

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(970) 731-6100 e-mail: wildlandhydrology@pagosa.net

BANKFULL: WHAT IT IS AND HOW TO LOCATE IT

WHY BANKFULL?
Several procedures in this manual require you to locate what is known as the "bankfull channel edge," or more simply as "bankfull." This is an important concept in understanding the workings of a stream.

HOW DOES A "BANKFULL" GET CREATED?
Most lower portions of streams in our area are alluvial, meaning that they create their own channels by moving sediment from the surrounding hillslopes and from the stream channel itself. Major episodes of such movement occur during floods and are called "channel-forming events." These events determine the size of the channel needed to convey the water. In a period of relatively stable climate and land-cover, a stream system will develop an equilibrium between its flows and the size of the channel, whereby the channel is large enough to contain the stream under most flow conditions. When flows are greater than this capacity, the stream overflows its banks and flooding occurs.

In such streams, the channel is usually big enough to contain a high-flow event that recurs on an average of every 1.5 years (which we call the "1.5-year flood"). Such a frequency of inundation is frequent enough that perennial vegetation can't grow there, either because its roots are too wet or its seedlings get swept away. So usually, what you'll see if you look at the cross-section of a stream channel is a sort of "bowl" that contains the stream most of the time, inside which no perennial vegetation grows, and a place over the top of this bowl where the water can flow during a high-water event greater than a 1.5-year flood. This "floodplain" may be on one or both banks, depending on the site.

WHAT ARE INDICATORS OF BANKFULL?
Most stream systems are in a continual cycle of change, and every site is unique; thus, no single indicator of bankfull can always get you the "right answer." There are several indicators which can help to identify the bankfull channel edge, and you should consider all that are present at a given site:

A. **Bank slope:** In stream channels with natural (undiked) riparian areas and a low, flat floodplain, the bankfull edge is located at the edge of this plain. Often the floodplain will slope down very gradually and then more abruptly. This abrupt slope-break is usually a good indicator. However, you may find such a slope-break on only one bank, or none at all, for instance if the channel has cut down into the streambed. Or the slope-break may be impossible to find on a bank that is slumping or undercut.

B. **Vegetation:** The bankfull edge is often indicated by a demarcation line between lower areas that are either bare or have aquatic and annual vegetation, and higher areas with perennial vegetation such as ferns, shrubs, and trees. (Keep in mind, though, that the vegetation line is always in transition, retreating during wetter periods and advancing during dryer ones. So except for ferns, you should rely most heavily on perennial vegetation which is more than 6 feet high.) One particular confusion arises from willow or alder trees growing within the bankfull channel, because the channel has migrated into them, or they fell into the stream and managed to reestablish themselves. Therefore, when you look at vegetation, you should also look at soils...

C. **Soils:** Look for a transition as you move up the bank, from cobble/gravel to sand/silt to soil. Above bankfull level, you should find old leaf litter forming into soil with organic matter. (Beware: this may be covered by flood deposits, so you may have to dig down.)

D. **Point bars and bank undercuts:** Often on the inside of meander bends, the stream will build up a bar of sediment from the eddy current created by the bend; the top of such a bar is the minimum height of bankfull. Similarly, on the outside of such bends, the stream will often undercut the bank and expose root mats. If you reach up beneath this mat, you can estimate the upper extent of the undercut. This would also be the minimum height of bankfull.

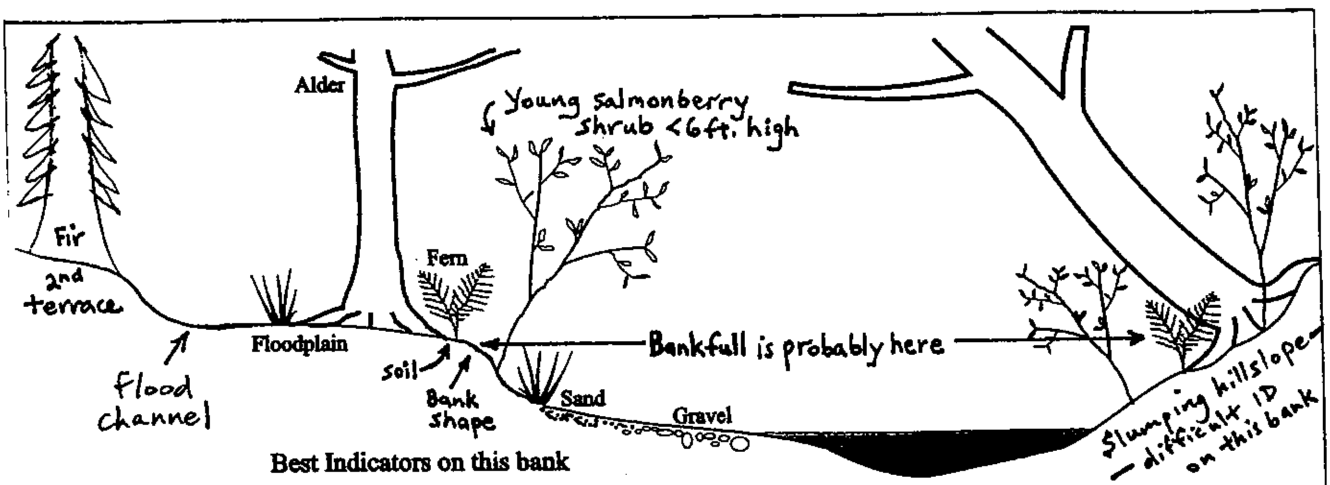
E. Lines on boulders/bedrock: If you're in a steep channel with no clear floodplain, look for the highest mineral-stain line or the lowest line of lichen or moss on stable rock.

F. Adjacent indicators: If the indicators are unclear where you're looking, try looking up- or downstream to see if there is a clear bankfull line from which you can extrapolate.

HOW SHOULD I LOCATE BANKFULL?

The following method was found by the TFW program to maximize data precision and minimize bias toward over- or under-estimation of bankfull elevation:

1. Start on the bank with the best bankfull indicators.
   a. Move up the bank from the channel, observing the indicators listed above. When you reach a point at which you're no longer 100% sure that you're below bank-full, mark that level with a flag or stick.
   b. Then walk up to what is clearly dry land, and walk around, observing indicators and moving back toward the bankfull edge. When you're no longer 100% confident that you're above bankfull, mark that point.
   c. Reassess the indicators and your confidence levels, and consult with your fellow samplers, and make adjustments as needed.
   d. The bankfull channel edge is at the elevation point midway between these two points.
2. Now follow the same procedure on the other bank. If it is not possible to accurately identify the bankfull level on that bank (which often happens on the outside bank of a meander bend), locate it using a level line from the bankfull point on the first bank.



Typical bankfull ID situation, adapted from Pleus and Schuett-Hames, 1998.

(Also referenced for this section: Harrelson et al., 1994.)

Smith Creek Monitoring Group
Tape Down Survey

Location: Station 5- Smith Creek near Neuse
Watershed: Smith Creek/Neuse
Stream Notes:

Storm Data:
Date: ____________

STA (ft)	BKF depth (ft)	Notes
0.5		
1.5		
2.5		
3.5		
4.5		
5.5		
6.5		
7.5		
8.5		
9.5		
10.5		
11.5		
12.5		
13.5		
14.5		
15.5		
16.5		
17.5		
18.5		
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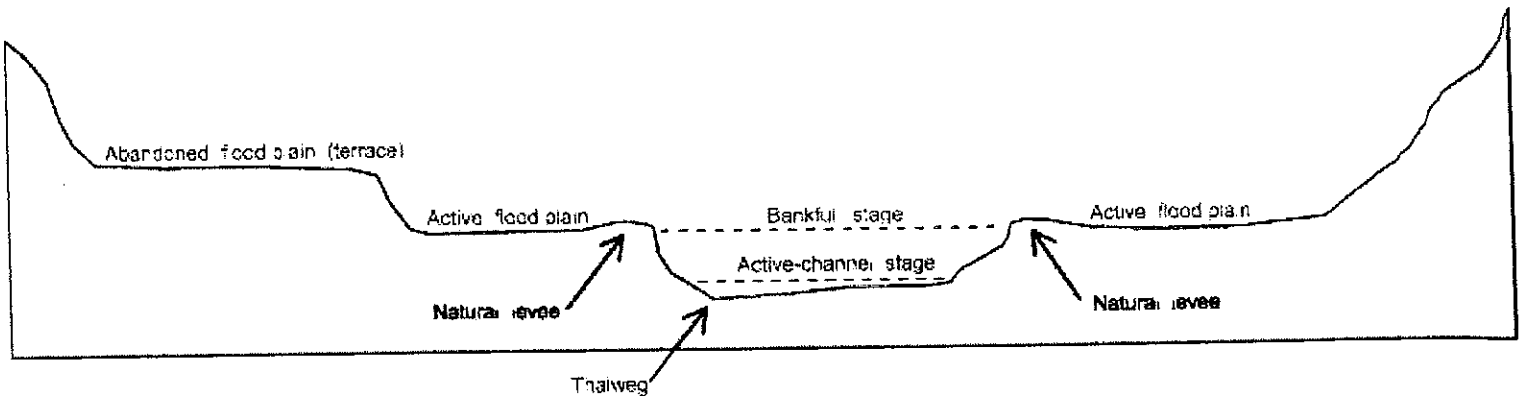
41.5		
42.5		
43.5		
44.5		
45.5		
46.5		
47.5		
48.5		
49.5		
50.5		
51.5		
52.5		
53.5		
54.5		

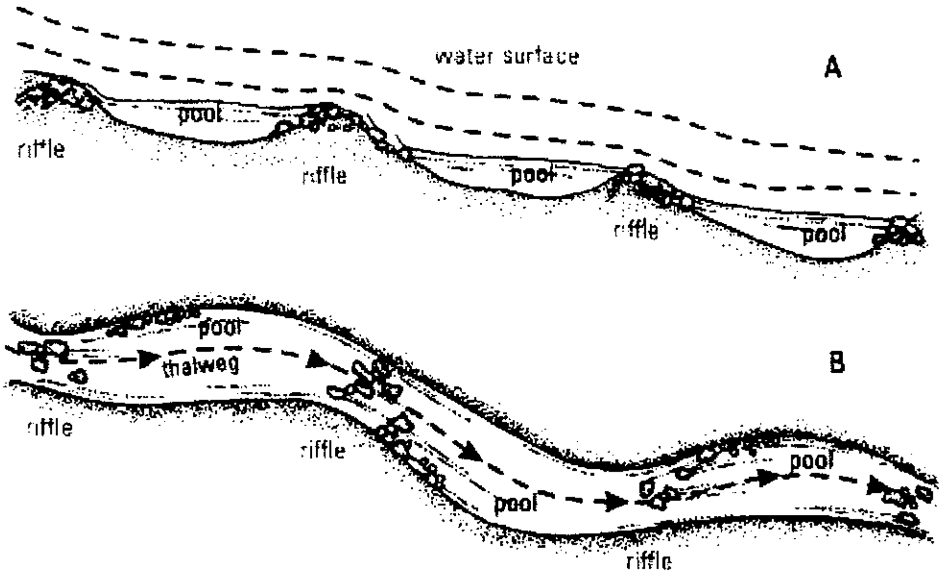
A bkf (sf)		ft
Ave Depth (D bkf)	2.29	ft
Max Depth (D max)	3.78	ft
W bkf (ft)	30'	ft
W/D = W bkf / D bkf		
Watershed Area (sq mi)	22.70	sq. mi.

thalweg- center of stream channel not middle of survey area

STA = station number horizontally from bank to bank
BKF = bankfull tape down depth measurement from horizontal in tenths
A bkf = area of bankfull = sum of bkf measurements
D bkf = average depth of all measurements
D max = thalweg
W/D = ratio



Abandoned flood plain (terrace)
Active flood plain
Bankful stage
Active flood plain
Active-channel stage
Natural levee
Natural levee
Thalweg


water surface
A
pool
riffle
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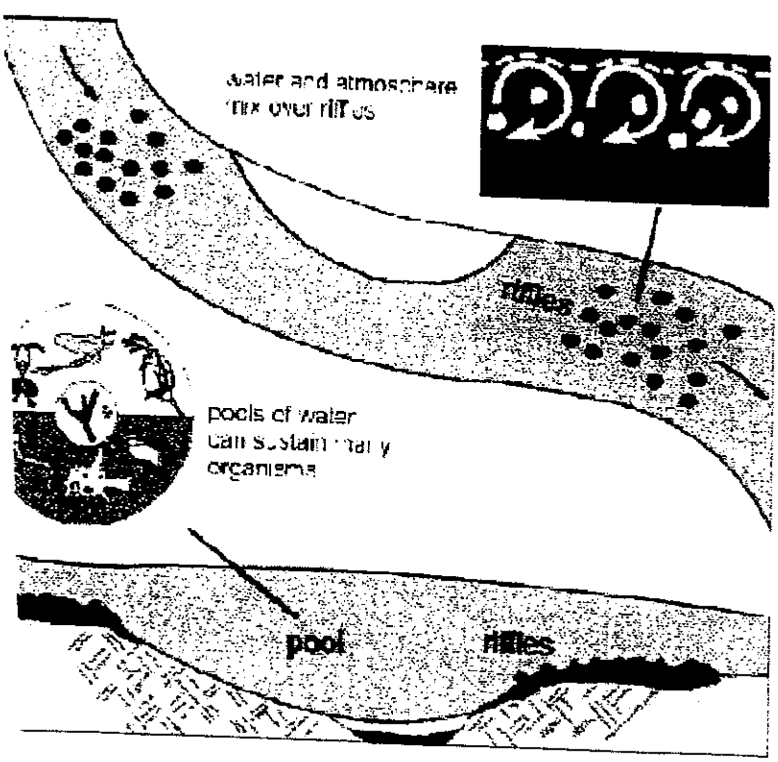
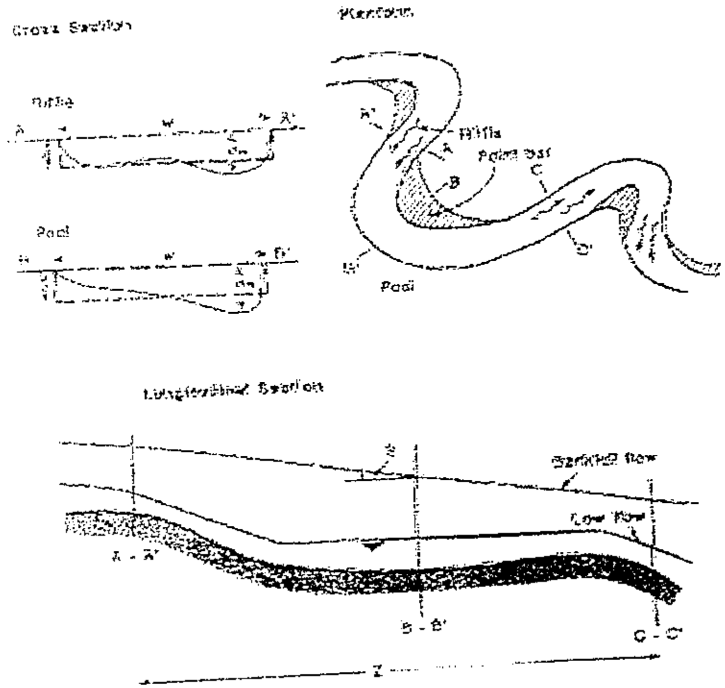
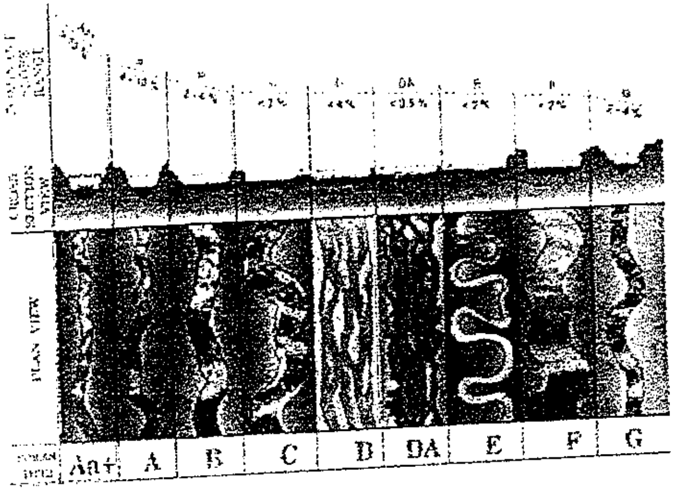
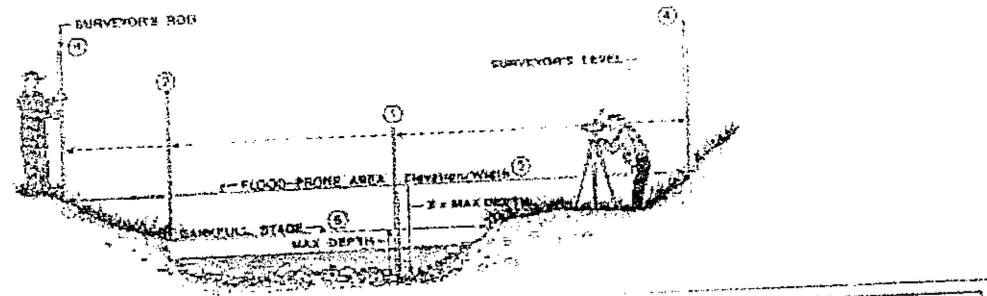
B
pool
thalweg
riffle
riffle
pool
pool
riffle

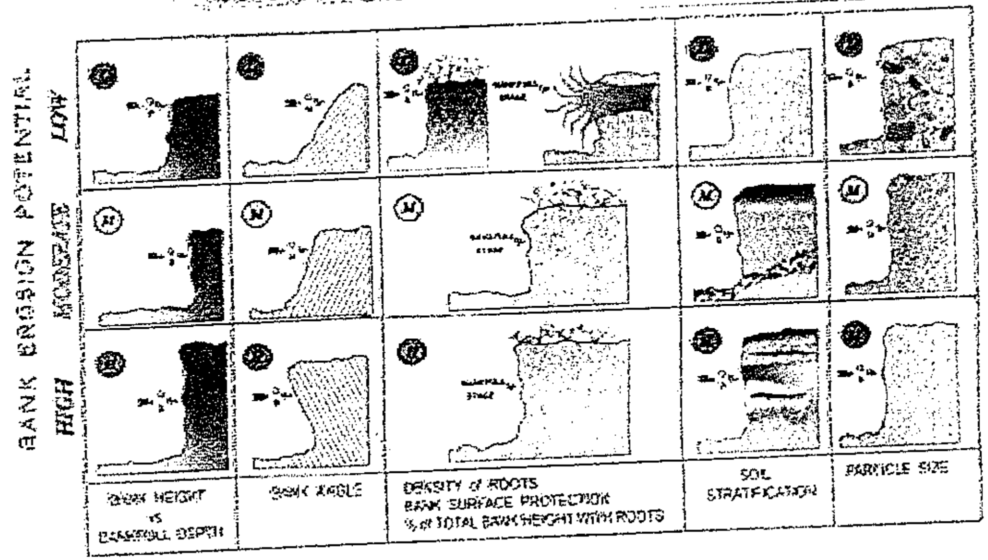

water and atmosphere mix over riffles
riffles
pools of water can sustain many organisms
pool
riffles

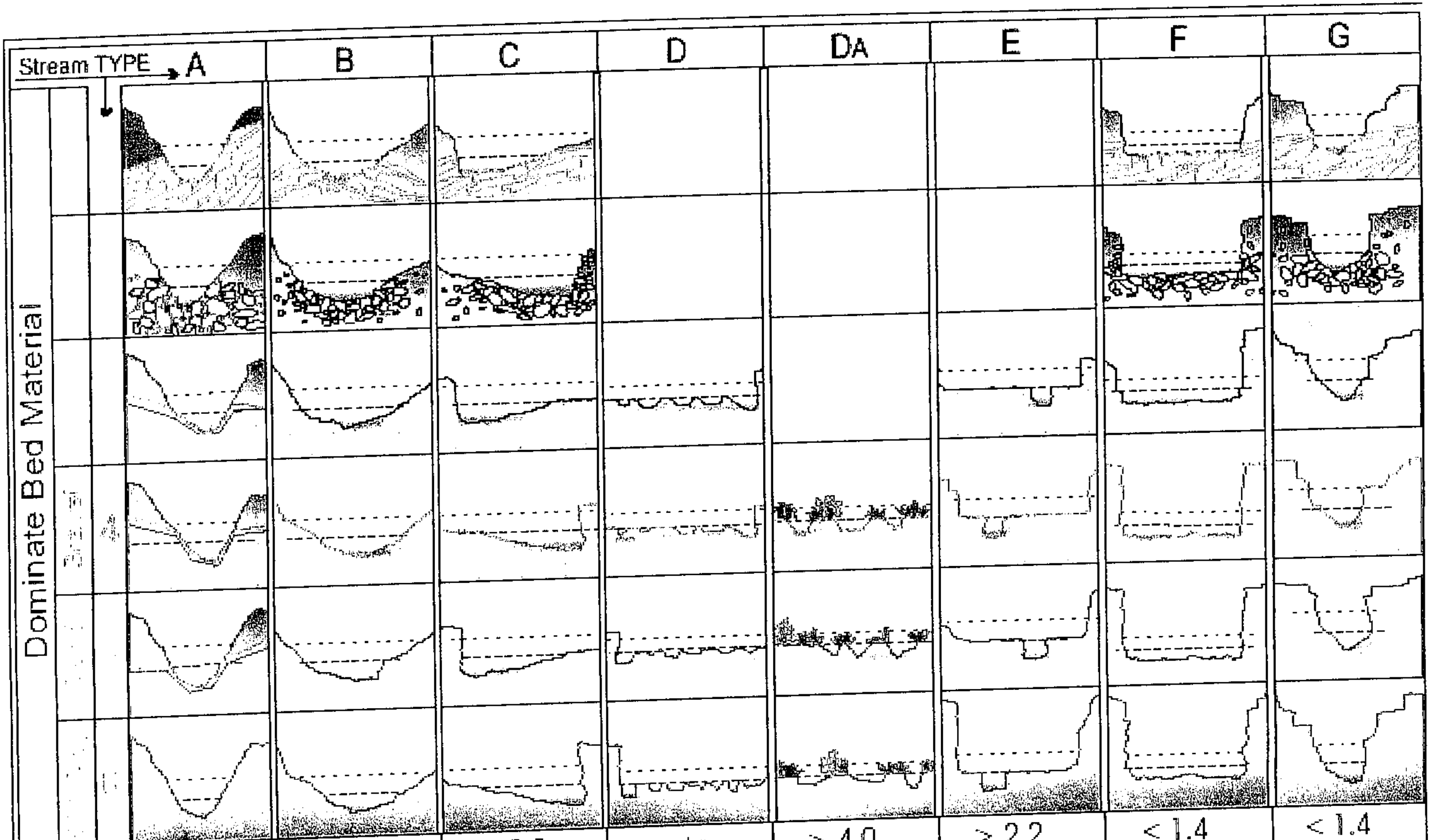


LONGITUDINAL, CROSS-SECTIONAL and PLAN VIEWS of MAJOR STREAM TYPES





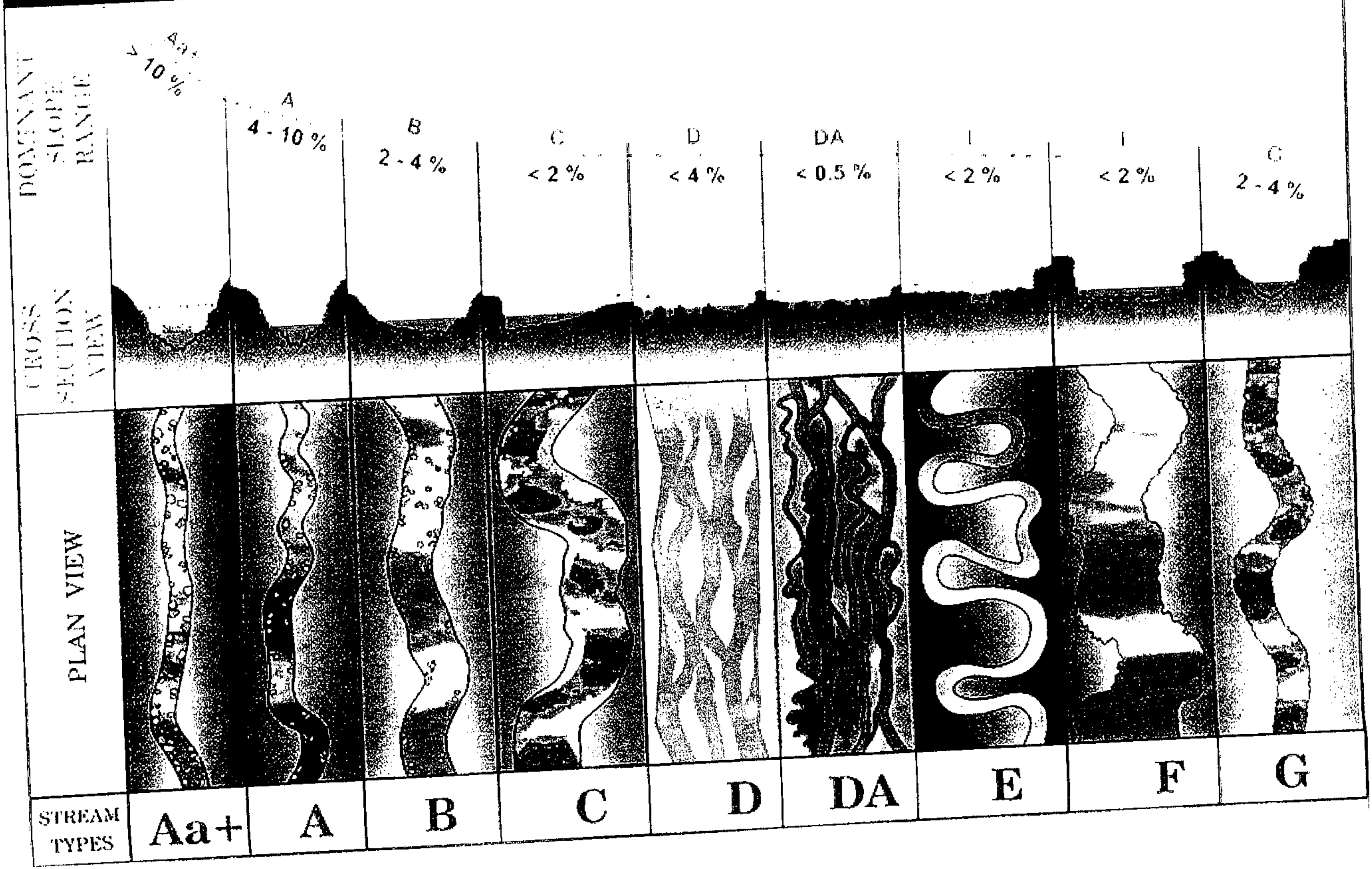




Stream TYPE	A	B	C	D	DA	E	F	G
Entrchmnt	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	> 1.5	> 1.2	> 1.2
H_20 Slope	.04-.099	.02-.039	< .02	< .04	<.005	< .02	< .02	.02-.039

1481 Stevens Lake Road Pagosa Springs, CO 81147
(970) 731-6100 e-r il: wildlandhydrology@pagosa.net

Rosgen Stream Classification System



FIELD PROCEDURE: PEBBLE COUNT

(From Kondolf 1997, Wolman 1954, and Schuett-Hames et al. 1994)

EQUIPMENT NEEDED:

- Rulers marked in "half-phi" classes (see below), with 1/8" welding rods projecting 8" beyond the end of the ruler
- latex disposable gloves, to protect against sharp objects in the water
- marked boot tips
- data sheet, clipboard, pencil

In this procedure, you will measure the particle size distribution of the surface sediment of your stream, which provides valuable information about its habitat and hydrology.

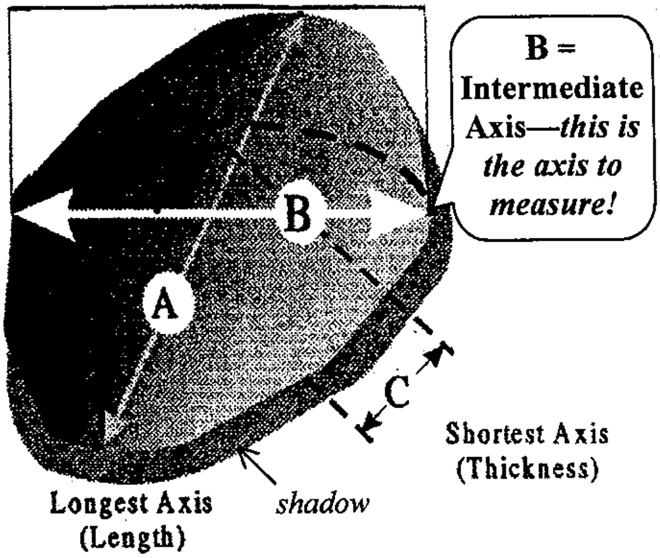
It is best for two people to perform this procedure: one to pick and measure rocks exclusively; and the other to record. A second counter cuts the time in half, but the counters must coordinate their crossings (see below).

1. If possible, do your sampling in the area of your cross-section transect. However, the site needs to be a channel-spanning riffle or run[1], at a point where the flow and stream-bottom appear relatively homogeneous (e.g., no eddies or backwaters). If the cross-section transect is not appropriate, find a place that is. You may go outside your reach to find the best place possible if there is no appropriate area within it. (If you see broken glass or other dangerous trash in this area, take precautions, remove the trash, or find another area.) On your data sheet, indicate your sampling location.
2. The counter(s) will be walking back and forth within this riffle/run across the entire channel bottom where the stream runs during normal flows, from the foot (a.k.a. "toe") of one bank to the foot of the other. Often there is a non-woody vegetation line at this toe. Part of this area will probably be dry when you do your sampling; that just makes it easier to count!
3. Walk heel-to-toe straight across this channel. With each step, insert the welding-rod straight down to the stream-bottom along the line drawn at the tip of your boots.
4. Don't count bedrock, garbage, construction debris, or organic materials. If you come to an area of the channel that is bedrock only, skip over that area and move to an area with sediment (see #1 above).
5. Otherwise, measure whatever you ***first touch*** with the welding rod, be it silt, gravel, or a boulder.
6. If you hit fine sediment that covers a rock completely (not sporadically), count the fines, not the rock. You can tell if you've hit fines, because the rod will make a "scrunch" (sand/silt) or "squish" (mud") sound rather than a "thunk" (rock) or "thud" (rock covered by algae). You can confirm this fact in a couple of ways:
   a) Look for a plume of dirt that flows downstream after you lift up the rod.
   b) If you're not sure whether what covers the rock is silt or algae, jiggle the rock, and if the covering easily washes away, it is fine sediment, not algae.
7. If you've hit fine sediment, you don't need to pick it up. Just call out "fines," and the recorder will enter a tally in the "<4 mm" row.

(please see next page)

[1] Riffle = shallow area where water flows swiftly over gravel and rock, creating surface turbulence; run = area with little surface turbulence but relatively high velocity. Don't sample at pools or "glides" (places of deep, uniform-depth, slow-moving water).

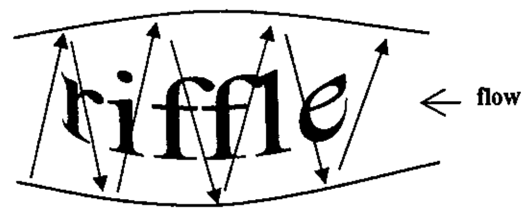
Otherwise, pick up the first piece you hit, and measure its diameter along its ***intermediate axis,*** which is perpendicular to the other two. To find this, first find the longest axis; then find the smallest axis that is perpendicular to the longest axis. There is now one more axis that is perpendicular to both the longest and shortest axes--that is the intermediate axis. See diagram below.



(From Schuett-Hames et al., 1994)

8. If you can't easily remove the rock from the bed, excavate around it and measure it in place. (You may have to "let the dust clear" for a few seconds.) The intermediate axis will be the smaller of the two exposed axes. (If it's a big rock, don't give yourself a hernia! Estimate whether it's embedded or not—i.e., does it look like just the "tip of the iceberg"?) You will tally these pieces in the "Embedded" column on your data sheet (see below).
9. For each piece of sediment measured, make ***two tallies*** on your data sheet:
   a) one in the appropriate row for the piece's size class, in ***either*** the "Loose" or "Embedded" column (not both!). The classes are: < 4 mm; 4-5.7 mm; 5.7-8 mm; 8-11.3 mm; 11.3-16 mm; 16-22.6 mm; 22.6-32 mm; 32-45.3 mm; 45.3-64 mm; 64-90.5 mm; 90.5-128 mm; 128-181 mm; 181-256 mm; 256-362 mm; 362-512 mm; >512 mm. (These increments are called "half-phi" classes; they increase by the square root of two and mimic data collected by putting sediment through successively finer sieves.)
   b) one in the "Total tally" row, to keep track of how many pieces you've counted.

   The recorder should verbally repeat each measurement back to the caller for error checking before placing the tally mark.
10. Repeat this procedure, walking heel-to-toe and crossing back and forth across the riffle. (It will go fast once you get into the rhythm!) Don't walk back along the same line you've walked before! (See diagram below.)



General transect scheme for pebble count

11. If you are on a big boulder and the next step is still on the same rock, tally that rock again.
12. If your foot falls on a rock that you can't stand on, put your foot on top of it and keep your weight on the other foot while you reach down with the rod. If you have to move your forward foot for whatever reason, try to make your next step start from wherever your forward foot would have been.
13. ***When 100 tallies are reached, all samplers must complete their crossing to the other side of the channel.*** So if you have a 100-ft. channel and two counters, one should start on each side, and they should meet in the middle!
14. In the "Sampler's Initials" box to the right of the data boxes, put <u>all</u> the initials of <u>one</u> sampler taking responsibility for the data. If more than one person worked on this data, put the initials of the person with the most experience or knowledge.

Water Flow Basics

You might be surprised to learn that even the Eno is affected by low water flow. Such conditions can have adverse effects on the entire aquatic community.

- When water levels are low, the water temperature can increase and result in less **dissolved oxygen** being available. This can be deadly to **macroinvertebrates** and fish.

- **Algae** can spread rapidly during low water flow, and these plants use tremendous amounts of oxygen as they decay. Fish kills can occur because of insufficient dissolved oxygen.

- During low water levels there is less habitat for river animals, and they become more vulnerable to predators.

- Low water flow also means low water volume. With less water available to dilute pollutants, toxic levels are reached more quickly.

- Last but not least, you might be forced to conserve water during low flow periods to make sure you have enough to drink and bathe.

We have talked a lot about low water levels but high flow levels affect us also. Heavy rains wash exposed soil into the river. This sediment can suffocate macroinvertebrates, kill fish eggs, and alter habitat. A lot of towns and cities divert rainwater into storm drains that empty into rivers. This stormwater can bring toxic materials into the river: vehicle oil and gas from pavement; chemicals used in farming and lawn care; overflow from **wastewater treatment plants;** and trash from dumps and other sources.

As you can see, water flow is very important to us. Using water wisely and protecting our river's **watershed** from unwise use are two ways we can help maintain a healthy and more natural water flow.

A beaver dam reduces water flow downstream, while providing a **wetland** habitat upstream. How does a beaver dam differ from a manmade dam?

Answer Sheet for On-Site Activity #1 (An Example)

How To Calculate Water Flow

A - Average length of flow space
B - Average width of flow space
C - Average depth of flow space
D - Time of flow through space

Solving for X = water flow rate in cubic ft./sec.

Equation: A x B x C ÷ D = X

A Average length of flow space

North bank 80 ft. + South bank 95 ft. = 175 ÷ 2 = 87.5 ft.

B Average width of flow space

Up river 75 ft. + Down river 83 ft. = 158 ÷ 2 = 79 ft.

C Average depth of flow space

1. 10 in. + 2. 18 in. + 3. 24 in. + 4. 12 in. + 5. 6 in. = 70 in.

70 in. ÷ 5 = 14 in. ÷ 12 in. = 1.17 ft.

D Average rate of flow through flow space

Ball 1

1. 20 sec. + 2. 22 sec. + 3. 18 sec. + 4. 23 sec. + 5. 21 sec. = 104 sec.

Ball 2

1. 21 sec. + 2. 26 sec. + 3. 24 sec. + 4. 21 sec. + 5. 22 sec. = 114 sec.

Ball 1 104 sec. + Ball 2 114 sec. ÷ 10 = 21.8 sec.

Equation: 87.5 ft. x 79 ft. x 1.17 ft. ÷ 21.8 sec. = 371 cubic ft./sec.

A B C D X

Worksheet for On-Site Activity #1

How To Calculate Water Flow

A - Average length of flow space
B - Average width of flow space
C - Average depth of flow space
D - Time of flow through space

Solving for X = water flow rate in cubic ft./sec.

Equation: A x B x C ÷ D = X

A Average length of flow space

North bank ________ ft. + South bank ________ ft. = ______ ÷ 2 = ______ ft.

B Average width of flow space

Up river ________ ft. + Down river ________ ft. = ________ ÷ 2 = ______ ft.

C Average depth of flow space

1.______ in. + 2.______ in. + 3.______ in. + 4.______ in. + 5.______ in. = ______ in.

______ in. ÷ 5 = ______ in. ÷ 12 in. = ______ ft.

D Average rate of flow through flow space

Ball 1

1._____ sec. + 2._____ sec. + 3._____ sec. + 4._____ sec. + 5._____ sec. = _____ sec.

Ball 2

1._____ sec. + 2._____ sec. + 3._____ sec. + 4._____ sec. + 5._____ sec. = _____ sec.

Ball 1 ____ sec. + **Ball 2** _____ sec. ÷ 10 = __________ sec.

Equation: ______ ft. x ______ ft. x ______ ft. ÷ ______ sec. = ________ cubic ft./sec.

A B C D X